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(54) **Title of the Invention: Method for Polishing Metal Film and Polishing Device**

(57) **[Abstract]**

[Object] The object of the present invention is to prevent metal contamination of a wafer surface when a metal film is polished.

[Means] Ozone feed ports 4 are made in polishing pad 5 of a polishing device and the W film that is formed on wafer 10 is removed using ozone and an abrasive particle solution that is fed from abrasive solution feed tube 3. As a result, metal contamination and plug depression can be prevented, and oxide film CMP becomes unnecessary.

1. Wafer 2. Wafer carrier 3. Abrasive particle solution feed tube

4. Ozone feed port 5. Polishing pad 6. Lathe

7. Ozone feed tube 8. Pressure regulator 9. Ozone generator

[Claims]

[Claim 1] A method for polishing metal film whereby a wafer on which a metal film has been formed is polished, this method of polishing metal film being characterized in that the metal is oxidized using an oxidant free of metal ions and the oxidized metal film is then removed using an abrasive containing abrasive particles.

[Claim 2] The method of polishing a metal film according to claim 1, characterized in that the oxidant used in the step whereby said metal film is oxidized is a gas.

[Claim 3] The method of polishing a metal film according to claim 2, characterized in that said gas is ozone.

[Claim 4] A polishing device for polishing a wafer on which a metal film has been formed, this polishing device characterized in that it comprises

means for oxidizing metal using an oxidant free of metal ions and

means for removing the oxidized metal film using an abrasive containing abrasive particles.

[Claim 5] The polishing device according to claim 4, characterized in that it is a device that uses a gas as the oxidant that oxidizes said metal film.

[Claim 6] The polishing device according to claim 4, characterized in that it is a device that uses ozone as said gas.

[Claim 7] The polishing device according to claim 4, characterized in that it further comprises a pressure regulator with which when said ozone is fed to the surface of a semiconductor substrate, the ozone feed velocity is increased at some point in the feed line between the ozone generator of the polishing device and an opening in the polishing pad on the lathe of the polishing device.

[Claim 8] The polishing device according to claim 4, characterized in that it is a device with which when said ozone is fed to the surface of a semiconductor substrate, ozone from the ozone generator is fed to the polishing pad surface separate from the abrasive particle solution feed tube inside a unit with an exhaust port.

[Claim 9] The polishing device according to claim 4, characterized in that it is a device with which when said ozone is fed to the surface of a semiconductor substrate, ozone from the ozone generator is

fed and mixed with the abrasive particle solution at some point in the abrasive particle solution feed tube and fed to the polishing pad on the lathe of the polishing device.

[Detailed Description of the Invention]

[0001]

[Industrial field of the invention] The present invention pertains to a method of producing a semiconductor device and a production device, particularly a method of polishing a metal film using chemical mechanical polishing (CMP) and a polishing device thereof.

[0002]

[Prior art] By means of conventional methods of producing a semiconductor device, contact hole 41 in under-wiring insulation film (BPSG film) 22 of Si substrate 38 is buried by 1,000 nm blanket W film 40 to fabricate a semiconductor substrate (wafer hereafter) and then this wafer is treated by chemical-mechanical polishing (CMP) which selectively acts on W film 40, as shown in Figure 9(a).

[0003] This CMP is performed on a polishing pad that rides on a turning platen. A slurry containing abrasive particles such as Al_2O_3 and an acid or base, such as $Fe(NO_3)_3$, H_2O_2, KOH, or NH_4OH, are used. This CMP is disclosed in the specification of USP 4,992,135. By means of this method, the surface of W film 40 that has buried contact hole 41 in BPSG film 39 becomes concave as shown in Figure 9(b) to form W film concave plug 42.

[0004] CMP, which acts selectively on BPSG film 39, has been performed as a method of alleviating W film concave plug 42, which has been depressed by the surrounding BPSG film 39. The slurry that is used for this CMP is a colloidal silica slurry that comprises compounds that selectively act on BPSG film 39, including H_2O_2 and KOH. This CMP is performed continuously until W film convex plug 43 is obtained, as shown in Figure 9(c).

[0005]

[Problems to be solved by the invention] Nevertheless, the conventional example shown in Figure 9 poses a problem in that there is a strong chance of metal contamination.

[0006] The reason for this is that the first step of W-CMP is performed using a slurry containing an oxidant such as $Fe(NO_3)_3$ or KOH. An oxidant such as $Fe(NO_3)_3$ is used here because it makes it possible to

strongly oxidize the W film and easily remove the film with abrasive particles. That is, it is used because the polishing speed is increased and throughput as related to the polishing step is raised.

[0007] The conventional example also poses a problem in that CMP with an oxide film slurry must be added as a second step.

[0008] This is done in order to eliminate the depression at the plug surface that is created by the first step of W-CMP and eliminate cracks in the oxide film surface. The second step of oxide film CMP is also used in order to remove to a certain level the metal impurities that adhere to the wafer surface as a result of the first step.

[0009] The purpose of the present invention is to provide a method of polishing a metal film and a polishing device with which metal contamination is alleviated.

[0010]

[Means for solving problems] In order to accomplish this purpose, the method of polishing a metal film of the present invention is a method whereby a wafer on which a metal film has been formed is polished, with the metal being oxidized using an oxidant free of metal ions and the oxidized metal film then being removed using an abrasive containing abrasive particles.

[0011] Moreover, the oxidant used in the step whereby this metal film is oxidized is a gas.

[0012] The above-mentioned gas is ozone.

[0013] The polishing device of the present invention is a polishing device that polishes a wafer on which a metal film has been formed, and this device comprises means for oxidizing metal using an oxidant free of metal ions and means for removing the oxidized metal film using an abrasive containing abrasive particles.

[0014] The oxidant that oxidizes this metal film is a gas.

[0015] Ozone is used as this gas.

[0016] Moreover, this polishing device further comprises a pressure regulator with which when the above-mentioned ozone is fed to the surface of the semiconductor substrate, the ozone feed velocity is increased at some point in the feed line between the ozone generator of the polishing device and the polishing pad opening on the lathe of the polishing device.

[0017] By means of one embodiment, when the above-mentioned ozone is fed to the surface of the semiconductor substrate, ozone from the ozone generator is fed to the polishing pad surface separate from the abrasive particle solution feed tube inside a unit with an exhaust port.

[0018] By means of another embodiment, when the above-mentioned ozone is fed to the surface of a semiconductor substrate, ozone from the ozone generator is fed and mixed with abrasive particle solution at some point in the abrasive particle solution feed tube and fed to the polishing pad on the lathe of the polishing device.

[0019] By means of the present invention, ozone, which is a gas, is used as the oxidant for the step whereby the metal film is polished. The polishing speed can be increased in the absence of metal impurities by this method. Moreover, since ozone is metal-free, the removal of metal impurities that was in the past accomplished by a second step is not necessary. Furthermore, there are none of the seams (voids) that tend to be produced in the center of the W plug by polishing using an H_2O_2 oxidant. As a result, a W plug can be efficiently formed by the CMP of the first step only, leading to an increase in the semiconductor device yield.

[0020]

[Embodiments of the invention] Embodiments of the present invention will now be described in detail while referring to the drawings .

[0021] (Embodiment 1) Figure 1 is a diagram showing embodiment 1 of the present invention.

[0022] The polishing device of embodiment 1 of the present invention shown in Figure 1 comprises wafer carrier 2 that supports semiconductor substrate (wafer hereafter) 1 face down; abrasive particle solution feed tube 3 that feeds abrasive particle solution onto polishing pad 5; ozone feed tube 7 that feeds ozone generated from ozone generator 9 through pressure regulator 8 onto polishing pad 5; and polishing pad 5, which feeds ozone from ozone feed tube 7 up from openings therein.

[0023] Figure 2 is an enlarged view of lathe 6 and polishing pad5, and Figure 3 shows the surface of the polishing pad. The abrasive particles used here are preferably alumina (Al_2O_3) particles or silica (SiO_2) particles. Moreover, polishing pad 5 is preferably a polishing pad made of a hard polyurethane foam body, a continuous foamed body of nonwoven cloth, or a layered structure thereof.

[0024] Next, the operation of embodiment 1 of the present invention will be described while referring to the polishing device in Figure 1. As shown in Figure 5(a), wafer 1 is formed by, for instance, layering BPSG film 13, PE-TEOS film 14, Ti film 15, TiN film 16, AlCu film 17, and blanket W film 18 in succession on Si substrate 12. As shown in Figure 5(a), wafer 1 on the surface of which metal film (blanket W film 18) is formed is supported by wafer carrier 2 and the back surface of wafer 1 is brought into contact with polishing pad 5 of lathe 6 and polished by abrasive particle solution fed from abrasive particle solution feed tube 3 and ozone fed from ozone generator 9. That is, by means of embodiment 1 of the present invention, metal is oxidized using an oxidant free of metal ions and the oxidized metal film is removed using an abrasive containing abrasive particles. It is possible to remove W film 18 that has buried the entire surface of wafer 1 having through holes and form W plug 20 as shown in Figure 5 (b) by this polishing. The quantity of flow and pressure of the ozone fed from ozone feed ports4 in Figure 1 must at this time be adjusted to the pressure under which the abrasive particle solution fed from abrasive particle solution feed tube 3 will not flow into ozone feed ports4.

[0025] (Embodiment 2) Figure 6 is a diagram showing embodiment 2 of the present invention. The polishing device of embodiment 2 of the present invention shown in Figure 6 comprises abrasive particle solution feed tube 22 that feeds abrasive particle solution onto wafer 25 supported by wafer carrier 6; ozone feed tube 21 that feeds ozone generated from the ozone generator onto wafer 25; small polishing pad 24 supported on polishing pad support carrier 23; polishing unit 28 whose polishing part is airtight for efficient use of ozone; and exhaust port 27 through which a constant volume of the saturated ozone at the bottom of polishing unit 28 is emitted. This embodiment is characterized in that the surface of wafer 25 to be polished is facing up.

[0026] Next, the operation of embodiment 2 of the present invention will be described while referring to Figure 6. Wafer 25 on the surface of which a metal film is formed (refer to Figure 5) is placed on wafer carrier 26 with the surface that will be polished facing up and is polished by abrasive particle solution fed from abrasive particle solution feed tube 22 and ozone fed from ozone feed tube 21. That is, by means of embodiment 2 of the present invention, metal is oxidized using an oxidant free of metal ions and the oxidized metal film is removed using an abrasive that contains abrasive particles. W plug 20 is formed

as shown in Figure 5(b) by this polishing. It is necessary in this case to emit ozone through exhaust port 27 of polishing unit 28 when the ozone that has been fed becomes saturated.

[0027] (Embodiment 3) Figure 7 is a structural diagram showing embodiment 3 of the present invention.

[0028] The polishing device of embodiment 3 of the present invention shown in Figure 7 comprises wafer 29 supported on wafer carrier 30; abrasive particle solution feed tube 36 that feeds abrasive particle solution onto polishing pad 31; ozone generator 33 that feeds ozone at some point in abrasive particle solution feed tube 36; ozone-abrasive particle mixture feed tube 37 for feeding mixed ozone and abrasive particle solution to polishing pad 31; and rotary pump 34 for efficiently feeding ozone-abrasive particle mixture to polishing pad 31.

[0029] Next, operation of embodiment 3 of the present invention will be described while referring to Figure 7. Wafer 29 on the surface of which a metal film has been formed is supported by wafer carrier 30 and abrasive particle solution fed from abrasive particle solution feed tube 36 and ozone fed from ozone generator 33 are mixed. The mixture that is fed from this ozone-abrasive particle mixture feed tube 37 polishes by being allowed to fall in drops onto polishing pad 31. The wafer is polished by allowing drops of the mixture fed from this ozone-abrasive particle mixture feed tube 37 to fall onto polishing pad 31. That is, by means of embodiment 3 of the present invention, metal is oxidized using an oxidant free of metal ions and the oxidized metal film is removed using an abrasive containing abrasive particles. W plug 20 is formed as shown in Figure 5(b) by this polishing. It is necessary at this time to operate rotary pump 34 that makes it possible to efficiently feed ozone (a gas) and abrasive particle solution 35 (a liquid) to polishing pad 31 once they have been mixed.

[0030] (Working Example 1) The embodiments of the present invention will now be described using specific examples.

[0031] Wafer 1 having a semiconductor device on which blanket W film 18 has been formed as shown in Figure 5(a) is anchored to wafer carrier 2 of the polishing device shown in Figure 1 and W film 18 is polished by abrasive particle solution fed from abrasive particle solution feed tube 3.

[0032] At this time, ozone feed ports 4 in polishing pad 5 are opened as shown in Figure 2 and ozone is fed from ozone generator 9 shown in Figure 1 through ozone feed tube 7 to polishing pad 5. This ozone replaces that oxidant that was in the past fed to the polishing pad as a solution. The quantity of flow and pressure of the ozone are adjusted by pressure regulator 8 so that abrasive particle solution does not invade ozone feed ports 4.

[0033] Moreover, Figure 3 shows the surface of polishing pad 5. Ozone feed ports 4 are made in polishing region 10 where wafer 1 contacts polishing pad 11 (5) during polishing. Ozone feed ports 4 have a diameter of 5 mm and are lined up diagonally.

[0034] Next, operation of Working Example 1 of the present invention will be described in detail while referring to the drawings.

[0035] Figure 5 shows the polishing steps of the polishing method of the present invention. The cross section of wafer 1 prior to polishing is shown in Figure 5(a). Once BPSG film 13 has been deposited to a thickness of 0.5 μm on Si substrate 12 using a normal-pressure CVD device, the film is heat treated with a lamp for 30 seconds in a nitrogen gas ambient atmosphere at 700°C to form an under-wiring insulation film. Next, titanium (Ti) film 15, titanium nitride (TiN) film 16, aluminum film 17 containing copper, and titanium nitride (TiN) film 16 are each deposited on BPSG film 13 by sputtering to a thickness of 1 μm and wiring is formed by patterning.

[0036] Next, plasma TEOS oxide film (PE-TEOS hereafter) 14 whose starting material is tetraethoxyorthosilicate (TEOS) is formed to 2 μm using plasma chemical vapor deposition (CVD hereafter). Then this PE-TEOS film 14 is smoothed by oxide film CMP (not illustrated).

[0037] Furthermore, the through holes on the wiring are opened by reactive etching and titanium nitride (TiN) film 16 is deposited to 0.1 μm by sputtering. Then blanket W film 18 is formed by CVD. Wafer 1 shown in Figure 5(a) is polished using the polishing device shown in Figure 1. An alumina particle solution with a pH of 4.0 and a particle diameter of 50 nm is used for the abrasive particles for polishing, and ozone, which is a gas, is used as the oxidant. The alumina particles are allowed to fall in drops from abrasive particle solution feed tube 9 directly onto polishing pad 5. The ozone is made by ozone generator 9 and is sent through pressure regulator 8 to ozone feed tube 7 in lathe 6. Moreover, ozone is sent to wafer 1,

which is turning as it is being held in place, and the surface of polishing pad 5, which is turning as abrasive particle solution is falling thereon in drops. The polishing conditions at this time are 5 rpm as the number of revolutions of lathe 6; 35 rpm as the number of revolutions of wafer carrier 2 supporting wafer 1; 5.0 psi as the load applied to wafer 1; 100 cc/min as the quantity of flow of the abrasive particle solution; 120 g/m^3 as the ozone feed concentration; and 1.5 atmospheres as the ozone feed pressure. This ozone feed pressure is used in order to prevent the abrasive particle solution that is at the same time being fed to the surface of polishing pad 5 from flowing into ozone feed ports 4.

[0038] W plug 20 is obtained as shown in Figure 5(b) once W film 18 at the surface of wafer 1 has been completely removed using the above-mentioned polishing conditions. The polishing speed at this time was increased to approximately 1.9-times the polishing speed when H_2O_2 is used as the oxidant free of metal, as shown in Figure 8. Thus, a CMP step is established with which the polishing speed is increased and there are no metal impurities. Moreover, when ozone is used as the oxidant there are none of the cracks in the oxide film surface that in the past have been removed by a second step and a smooth surface is obtained, making the conventional second step unnecessary. Furthermore, it is possible to curtail treatment time per wafer because of the fast polishing speed and therefore, throughput of semiconductor production can be raised.

[0039] It should be noted that although alumina particles with a diameter of 50 nm were used here, the same results are obtained when another particle diameter or another type of particle is used.

[0040] (Working Example 2) The composition of Working Example 2 will now be described in detail while referring to the drawings.

[0041] Wafer 25 on which blanket W film 18 has been formed as shown in Figure 5(a) is anchored to wafer carrier 25 of the polishing device shown in Figure 6 so that the surface that will be polished faces up and W film 18 is polished using abrasive particle solution fed from abrasive particle solution feed tube 22 and ozone fed from ozone feed tube 21. Polishing unit 28 with an airtight polishing part for efficient use of ozone of the polishing device in Figure 6 and exhaust port 27 for emitting a constant amount of the ozone that has become saturated at the bottom of this polishing unit 28 are open.

[0042] Operation of Working Example 2 of the present invention will now be described in further detail while referring to the drawings.

[0043] Figure 5 shows the polishing steps of the polishing method of the present invention. A wafer having the structure in Figure 5(a) is made as in Working Example 1. A wafer having the structure in this Figure 5(a) is polished using the polishing device shown in Figure 6. An alumina particle solution with a pH of 4.0 and particle diameter of 50 nm is used for the abrasive particles during polishing and ozone (gas) is used for the oxidant. The alumina particles are allowed to fall in drops from abrasive particle solution feed tube 22 directly onto wafer 25. This wafer 25 is placed on wafer carrier 26 so that the surface that will be polished faces up. Furthermore, ozone made by an ozone generator is sent through ozone feed tube 21 to wafer 25. In addition, the polishing conditions at this time are 50 rpm as the number of revolutions of polishing pad support carrier 23 that supports polishing pad 24; 35 rpm as the number of revolutions of wafer carrier 26 that supports wafer 25; 5.0 psi as the weight applied to polishing pad 24; 100 cc/min as the quantity of flow of the abrasive particle solution; 120 g/m^3 as the ozone feed concentration; and 1.0 atmosphere as the ozone feed pressure. By means of the present method, the saturated ozone inside polishing unit 28 must be emitted through exhaust port 27 because ozone is continuously being fed to the polishing part. The exhaust pressure at this time is preferably 20 to 50 mm H_2O. W plug 20 shown in Figure 5(b) is obtained once W film 18 at the surface of wafer 25 has been completely removed under the above-mentioned polishing conditions. As in Working Example 1, the polishing speed at this time is the polishing speed shown in Figure 8. Thus, a CMP process is established with which the polishing speed is increased and there are no metal impurities. Moreover, even if the polishing device in Figure 6 is used, when ozone is used as the oxidant there are none of the cracks in the oxide film surface that in the past have been removed by a second step and a smooth surface is obtained, making the conventional second step unnecessary. Furthermore, it is possible to curtail treatment time per wafer because of the fast polishing speed and therefore, throughput of semiconductor production can be raised.

[0044] As in Working Example 1, it should be noted that although alumina particles with a diameter of 50 nm were used here, the same results are obtained when another particle diameter or another type of particle is used.

[0045] (Working Example 3) The composition of Working Example 3 of the present invention will now be described in detail while referring to the drawings.

[0046] W film 18 is polished using wafer 29, which is wafer 25 on which blanket W film 18 has been formed as shown in Figure 5(a) supported on wafer carrier 30 of the polishing device shown in Figure 7; ozone generator 33 capable of feeding ozone at some point into abrasive particle solution feed tube 36 on polishing pad 31; and further, ozone-abrasive particle mixture feed tube 37 for feeding mixed ozone and abrasive particle solution to polishing pad 31. The mixture of ozone (gas) and abrasive particle solution (liquid) must in this case be efficiently fed to polishing pad 31 using rotary pump 34.

[0047] Next, operation of Working Example 3 of the present invention will now be described in detail while referring to the drawings.

[0048] Figure 5 shows the polishing steps of the polishing method of the present invention. A wafer having the structure in Figure 5(a) is made as in Working Example 1. A wafer having the structure in this Figure 5(a) is polished using the polishing device shown in Figure 7. An alumina particle solution with a pH of 4.0 and particle diameter of 50 nm is used for the abrasive particles during polishing and ozone (gas) is used for the oxidant. Wafer 29 on the surface of which a metal film is formed is supported by wafer carrier 30, and abrasive particle solution fed from abrasive particle solution feed tube 36 and ozone fed from ozone generator 33 are mixed. Polishing is performed by allowing the mixture fed from ozone-abrasive particle mixture feed tube 37 to fall in drops onto polishing pad 31. Rotary pump 34 must be operated at this time so that the ozone (a gas) and abrasive particle solution 35 (a liquid) will be efficiently fed to polishing pad 31 once they have been mixed. In addition, the polishing conditions at this time are 35 rpm as the number of revolutions of wafer carrier 30 that supports wafer 29; 50 rpm as the number of revolutions of lathe 32; 5.0 psi as the weight applied to wafer 29; 100 cc/min as the quantity of flow of the abrasive particle solution; 120 g/m^3 as the ozone feed concentration; and 1.5 atmospheres as the ozone feed pressure. W plug 20 shown in Figure 5(b) is formed by this polishing.

[0049] W plug 20 shown in Figure 5(b) is obtained once W film 18 at the surface of wafer 25 has been completely removed under the above-mentioned polishing conditions. As in Working Example 1, the polishing speed at this time is the polishing speed shown in Figure 8. Thus, a CMP process is established

with which the polishing speed is increased and there are no metal impurities. Moreover, even when the polishing device in Figure 7 is used, there are none of the cracks in the oxide film surface that in the past have been removed by a second step and a smooth surface is obtained, making the conventional second step unnecessary. Furthermore, it is possible to curtail treatment time per wafer because of the fast polishing speed and therefore, throughput of semiconductor production can be raised.

[0050] As in Working Example 1 and Working Example 2, it should be noted that although alumina particles with a diameter of 50 nm were used here, the same results are obtained when another particle diameter or another type of particle is used.

[0051]

[Result of the Invention] As previously described, by means of the present invention, metal contamination can be prevented by performing W-CMP without using a slurry containing an oxidant such as $Fe(NO_3)_3$ or KOH, and it is possible to maintain the high polishing speed that was possible in the past with oxidants such as $Fe(NO_3)_3$ by using ozone.

[0052] Furthermore, ozone is used and therefore, the oxidant-induced erosion of W film that is seen with conventional oxidants does not occur, a concave shape is not formed at the plug surface, and the conventional second step of CMP with an oxide film slurry becomes unnecessary. Moreover, the oxidant is free of metal and therefore, removal of the metal impurities that were deposited on the waver surface during the first step in the past is not necessary.

[Brief Description of the Drawings]

[Figure 1] is a drawing showing the polishing device of embodiment 1 of the present invention.

[Figure 2] is a detailed enlargement of the lathe and polishing pad of the polishing device of embodiment 1 of the present invention.

[Figure 3] is a front view showing the polishing pad of embodiment 1 of the present invention.

[Figure 4] is a front view of the polishing pad that describes the polishing region at the surface of the polishing pad.

[Figure 5] is a cross section showing the order of the steps of the polishing method of the embodiments of the present invention.

[Figure 6] is a diagram showing the polishing device of Embodiment 2 of the present invention.

[Figure 7] is a diagram showing the polishing device of embodiment 3 of the present invention.

[Figure 8] is a diagram showing the result of the embodiments of the present invention.

[Figure 9] is a diagram showing the polishing method of prior art.

[Definition of Symbols]

1, 25, 19.	Wafer (semiconductor substrate)
2, 26, 30.	Wafer carrier
3, 22, 36.	Abrasive particle solution feed tube
4.	Ozone feed port
5, 24, 31.	Polishing pad
6, 32.	Lathe
7, 21.	Ozone feed tube
8.	Pressure regulator
9, 33.	Ozone generator
10.	Polishing region
12, 38.	Si substrate
13.	BPSG film
14.	PE-TEOS film
15.	Ti film
16.	TiN film
17.	AlCu film
18, 40.	Blanket W film
19.	Through-hole part
20.	W plug
23.	Polishing pad support carrier
27.	Exhaust port
28.	Polishing unit

34. Rotary pump

35. Abrasive particle solution

37. Ozone abrasive particle mixture feed

39. Under-wiring insulating film

41. Contact hole

42. W film concave plug

43. W film convex plug

[Figure 1]

1. Wafer
2. Wafer carrier
3. Abrasive particle solution feed tube
4. Ozone feed port
5. Polishing pad
6. Lathe
7. Ozone feed tube
8. Pressure regulator
9. Ozone generator

[Figure 2]

4. Ozone feed port
5. Polishing pad
6. Lathe
7. Ozone feed tube

[Figure 3]

4. Ozone feed port

5. Polishing pad

10. Polishing region

[Figure 4]

1. Wafer

10. Polishing region

11. Polishing pad

[Figure 5]

12. Si substrate

13. BPSG film

14. PE-TEOS film

15. Ti film

16. TiN film

17. AlCu film

18. Blanket W film

20. W plug

[Figure 6]

21. Ozone feed tube

22. Abrasive particle solution feed tube

23. Polishing pad support carrier

24. Polishing pad

25. Wafer

26. Wafer carrier

27. Exhaust port

28. Polishing unit

[Figure 7]

29. Wafer

30. Wafer carrier

31. Polishing pad

32. Lathe

33. Ozone generator

34. Rotary pump

35. Abrasive particle solution

36. Abrasive particle solution feed tube

37. Ozone-abrasive particle mixture feed tube

[Figure 8]

Polishing speed (Å/min)

H_2O_2 oxidant Ozone oxidant

Type of oxidant